

CORMORANT RESEARCH AND IMPACTS TO SOUTHERN AQUACULTURE

SCOTT J. WERNER, USDA-APHIS-Wildlife Services-National Wildlife Research Center, Mississippi Research Station, P.O. Drawer 6099, Mississippi State University, Mississippi 39762.

ABSTRACT: Several North American waterbird species were negatively affected by compromised environmental quality by the mid-twentieth century. Double-crested cormorant populations responded to increased environmental regulations in the United States in the early 1970s. The abundance of cormorants wintering in southern states (especially Alabama, Arkansas, Louisiana, and Mississippi) increased concurrently with a marked increase in catfish, crawfish, and bait fish production in these states since 1980, thus increasing regional concern regarding production losses to these industries. Cormorants wintering in Mississippi have increased nearly 225% since 1990. Food habit studies, bioenergetic predictions, and captive-bird foraging experiments indicate that individual cormorants consume approximately 0.5 to 0.7 kg (1 to 1.5 pounds; i.e., about 10 fingerlings) of catfish fingerlings per day. Although no present management techniques permanently redistribute cormorants, dispersal of night roosts remains the most effective method to temporarily deter cormorants from primary aquaculture areas. Ongoing investigations will improve our understanding of cormorant impacts to catfish production, and the annual movement patterns and population biology of North American cormorants. Given concerns regarding cormorant impacts to commercial and recreational fisheries in the United States, management objectives should highlight minimized impacts to economic and recreational opportunities, rather than target populations of breeding and/or wintering double-crested cormorants.

KEY WORDS: cormorant, bird damage, bird control

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INTRODUCTION

Double-crested cormorants (*Phalacrocorax auritus*) have been observed to breed in nearly each state and province east of Texas and Manitoba (Wires and Cuthbert 2000). Cormorants traditionally (late 19th and early 20th centuries) bred in northern United States, including the Great Lakes region of the U.S. and Canada, and wintered in the Gulf Coast region (Lewis 1929). Several fish-eating birds (including cormorants) were negatively affected by concentrated contaminants (e.g., organophosphates, urban runoff) throughout their ranges from the mid-1940s through 1970. As a result of improved environmental regulations (e.g., 1972 Clean Water Act), populations of many colonial waterbirds have recovered since 1970. Today, great cormorants (*Phalacrocorax carbo*) in Europe and Asia, and double-crested cormorants in North America are most abundant. Thus, concerns regarding cormorant impacts to fisheries are presently cosmopolitan.

Land use and environmental policy changes have also affected the quality of wintering habitat and subsequent migratory behaviors of double-crested cormorants. Given all-time low prices for cotton and soybeans in southern states in the early 1980s, many farmers converted to catfish aquaculture (i.e., commercial culture) in Mississippi, Arkansas, and surrounding states. By the mid-1980s, fewer cormorants migrated completely southward to the Gulf of Mexico each year, and cormorant abundance progressively increased in the upper delta region of the Mississippi River. Double-crested cormorants are presently the primary predator of catfish cultured in southern states. The Mississippi Field Station of the National Wildlife Research Center was established in 1988 to investigate fish-eating bird population trends, impacts to southern aquaculture, and alternatives for damage management.

CORMORANT POPULATION TRENDS

The interior population of double-crested cormorants (accounting for approximately 60% of double-crested cormorants breeding in North America) was recently estimated as one to two million birds (Hatch 1995). The abundance of cormorants wintering in the delta region of Mississippi has increased by nearly 225% since the early 1990s (Glahn et al. 2000a). Over 60,000 cormorants have wintered in the delta region of Mississippi since the winter of 1997-98 (in over 75 night roosts), despite the March 1998 Standing Depredation Order (USFWS 1998) which enables aquaculture producers in 13 states to take, without a federal permit, double-crested cormorants that are consuming cultured fish on their aquaculture facilities. An additional 7,000 to 17,000 cormorants and 36 night roosts were observed during aerial surveys of cormorants near Arkansas catfish production in February to April 1999 (Werner, unpubl. data).

Cormorants migrate to southern aquaculture states in October and return to traditional breeding colonies in the Great Lakes region of the U.S. and Canada in April to May each year. The abundance of wintering cormorants is greatest in the delta region Mississippi from January through March (Glahn et al. 2000a). Few individuals, however, have been observed throughout recent years in southern states, and breeding colonies have been recently observed in Mississippi (Reinhold et al. 1998) and Arkansas.

CORMORANT IMPACT ASSESSMENT

Cormorant Predation

Various studies have been conducted to assess cormorant impacts to southern aquaculture. Observations of cormorants foraging at catfish farms revealed that a group of 30 cormorants feeding throughout the day could consume half of the fingerlings stocked in an 8 ha pond

within 170 days (Stickley et al. 1992). Cormorants observed foraging at a captive-bird research facility consumed approximately 0.5 to 0.7 kg (1 to 1.5 pounds; i.e., about 10 fingerlings) of catfish fingerlings per day (Glahn, unpubl. data). During their food habits study, Glahn et al. (1995) found that approximately half of the cormorant diet (by mass) was composed of catfish fingerlings (averaging 16 cm long), and the remaining diet items were predominantly gizzard shad (*Dorosoma cepedianum*).

Considering the specific physiological attributes of double-crested cormorants, their relative abundance, and the state of the aquaculture industry (acreage and production), Glahn and Brugger (1995) developed a bioenergetics model for double-crested cormorant impacts to southern catfish production. These authors suggested that the cost of replacing the 18 to 20 million fingerlings that were annually consumed by cormorants in the delta region of Mississippi (from 1989 to 1991) would be approximately \$2 million. Given the marked increase in cormorant winter populations since this period, Glahn et al. (2000a) recently estimated this replacement cost to be approximately \$5 million.

A controlled pen study is presently being conducted at the NWRC-Mississippi Research Station to investigate the impact of cormorant predation to gross catfish production (Glahn, unpubl. data). Six replicate, 0.1 acre ponds will be sectioned in half to provide an excluded pond area and a treated pond area where cormorants will be permitted to forage. Test ponds will be stocked with 10 to 15 cm (4 to 6 inch) fingerlings in early March at densities that represent present industry standards (5,000 fingerlings per acre). Since several non-commercial fishes are typically present in farm ponds, a buffer prey species will also be stocked at equal biomass. Following the foraging treatment period, cormorants will be removed from ponds and catfish will be cultured through October using modern industry procedures (e.g., feeding, water management). The abundance and mass of catfish in treated and control pond halves will be compared at the conclusion of the growing season. Since "natural" mortality will be observed within pond halves excluded from cormorant predation, this study will provide an understanding of cormorant impacts to gross catfish production.

Ecological Impacts of Cormorants in Primary Aquaculture States

In addition to predation impacts to commercial and recreational fisheries, abundant fish-eating bird species may also affect their wintering or breeding habitats, and cohabitant waterbirds. Approximately 85% of the fertilizing constituents in double-crested cormorant guano is composed of phosphorus (i.e., phosphoric acid; Lewis 1929). Given the concentration of cormorants at night roosts near southern aquaculture and near breeding colonies, cormorant-induced nutrient enrichment in adjacent aquatic environments is a plausible hypothesis.

Water samples were collected at two locations directly beneath a cormorant night-roost site in southeastern Arkansas in 1999. One water sample (standard) was collected at each of two additional locations, approximately 1.5 to 3 km from the night roost. At each

sampling location, one subsample was collected within 12 cm of the water surface, and another subsample was collected within 0.5 m of the bottom (i.e., eight subsamples were collected). Water sampling was replicated at a newly established breeding colony in southwestern Arkansas in June 1999. Water samples were analyzed for differences in nitrogen, phosphorus, potassium (i.e., nutrient spectrophotometry), and dissolved oxygen immediately beneath cormorants versus away from the night roost and breeding colony.

Sediment samples were also collected at all locations at the night roost in southeastern Arkansas, and were subsequently tested for acute and chronic ecotoxicity. Compared to standard samples, reactive phosphorus (+1 to 2 mg/L) was 200 to 800% beneath roosts of 1,000 to 8,000 cormorants during the winter of 1998-99. Reactive phosphorus was approximately six times greater beneath the active cormorant breeding colony compared to standard samples (Werner, unpubl. data). This enrichment, however, may supplement phosphorus-limited waters in the interior of the United States, and is far less than the observed nutrient enrichment via great cormorants in the Netherlands (+10 mg/L; Barendregt et al. 1995). Toxicological effects of sediment from the night roost were insignificant, thus indicating benign ecological relations between abundant cormorants and their wintering and breeding habitats in the southern United States.

MANAGEMENT OF CORMORANT IMPACTS TO SOUTHERN AQUACULTURE

The effectiveness of exclusion techniques to reduce cormorant depredation at aquaculture facilities has been reviewed by several authors (e.g., Mott and Boyd 1995; Reinhold and Sloan 2000). Overhead wires and monofilament, floating ropes, and inflatable effigies (Stickley and King 1995; Stickley et al. 1995) have been used to exclude cormorants from specific fish ponds. Mott et al. (1995) used floating ropes to prohibit cormorants from landing on catfish production ponds in Mississippi. Ropes were placed at 15 to 17 m intervals, perpendicular to prevailing winds. Although floating ropes were effective in reducing cormorant numbers up to 95% on test ponds, cormorants were observed to adapt to the ropes after a few weeks.

Exclusion techniques at individual aquaculture facilities are moderately effective during testing, though few producers presently use these techniques due to the large size of aquaculture ponds and farms. Given the gregarious nature of cormorants and the availability of bottomland hardwoods adjacent to southern aquaculture facilities, dispersal of night roosts is presently the most effective, non-lethal technique to temporarily deter cormorants from southern aquaculture facilities (Mott et al. 1992, 1998).

Given the need for effective management of cormorant impacts, Glahn et al. (2000b) developed a "Strategic Plan to Manage Double-crested Cormorant Damage to Southern Aquaculture." Glahn et al. recommend the following: evaluation of regional control options; investigation of flyway movements; assessment of present population management strategies; development of a double-crested cormorant population model; and

development and implementation of an integrated management plan. The U.S. Fish and Wildlife Service is presently developing an Environmental Impact Statement and a National Cormorant Management Plan. Given the longevity of double-crested cormorants and their relatively low reproductive output, Dolbeer (1998) recommended that North American cormorant populations could be most effectively managed by culling adults rather than reproductive controls (e.g., egg-oiling). Thus, management alternatives should accommodate flyway-based objectives and region-specific techniques.

Since the impetus for the U.S. Cormorant Management Plan was concern regarding the ecological impacts of cormorants (e.g., to commercial and recreational fisheries), management objectives should highlight socially acceptable impacts (e.g., to economic and recreational opportunities), rather than target populations of breeding and/or wintering cormorants. Thus, effective management alternatives can be deduced from relating cormorant populations to resource economics and indices of resource integrity (e.g., fish production, water quality).

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